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BUREAU OF MINES

VAN. H. MANNING, DIRECTOR

METAL-MINE ACCOUNTING

BY

C. B. HOLMES

WASHINGTON
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METAL-MINE ACCOUNTING.

By C. B. Holmes.

INTRODUCTION.

The subject of cost keeping in mining, milling, and smelting operations has been dealt with often, but mostly with regard to forms for cost sheets, pay rolls, time cards, warehouse requisitions, and other plant forms, without any explanation of bookkeeping methods necessary for their compilation.

The simple system of mine accounting outlined in this book should enable mining companies to keep correct records of costs and metallurgical data, even though the accountant may have had no previous experience with mine accounts. Such records, in addition to being essential to the proper management of a mining enterprise, and indispensable in the preparation of tax returns, may furnish valuable information which is of interest to the Bureau of Mines and can be published for the benefit of the mining industry. In this discussion I present a month's operations of a company after it has been incorporated, construction work completed, and plant ready to operate, development work by previous owners having opened up a tonnage sufficient to start mining. Construction accounting is also taken up and suitable forms are shown.

With minor changes this system can be applied to a copper mine treating the ore by regular milling methods or by oil flotation or both; to a gold and silver mine using the cyanide process; to a lead-silver mine; or in fact to any underground metal-mining operation, and the ordinary methods of treating the ore. In the final chapter of this book you will find how the system can be adapted to different classes of mining and milling, or expanded to give more detail should your operation be large enough to require it; and if a smelting and converting plant is contemplated, how to keep your books with a view to obtaining correct costs and metallurgical data.

PRELIMINARY STEPS.

From a long experience in practical mine accounting, I am able to give the following advice:

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TO THE OWNERS OR BOARD OF DIRECTORS.

While the articles of incorporation are being prepared or a month before you are ready to start construction and development, you should employ four persons: First, a practical bookkeeper; second, an experienced warehouseman; third, a timekeeper; and fourth, a carpenter foreman.

Explain to the bookkeeper what the nature of the plant and operation is to be and let him get up a set of books and forms to cover the needs of the plant.

Decide on about how much you want to spend on an office building and warehouse, and if your warehouseman is experienced get his idea as to how the warehouse should be constructed.

While the carpenter foreman and his men are building an office and warehouse you will have time to look around for a superintendent or manager.

TO THE BOOKKEEPER.

After you have found out what the construction and operation program is to be and have formulated a set of books to cover, take the timekeeper and warehouseman into your confidence and teach them the accounts to which labor and material are to be charged. The accuracy of your books and reports depends solely upon them. You will not have time to follow the timekeeper around and see that he is correctly charging labor, or to see that all withdrawals from the warehouse are properly charged.

TO THE ENGINEERING DEPARTMENT (IF THE MINE HAS ONE).

If it has been left to you to decide what detailed costs of construction are to be kept, use a little judgment and don't make the costs so complicated that the whole force will have to be expert accountants in order to properly distribute their time or charge material drawn from the warehouse. I have seen cost schedules devised whereby a carpenter would have to charge his time to one account if he was driving nails into a floor and to another if he drove nails into the wall alongside of him.

By following this procedure the construction, development, mining, and other costs will reflect the actual amount of labor and material expended and not contain items prorated from a material shortage discovered after a few months, as is the practice with most mining ventures.

During the period of construction and preliminary development the overhead expense can be distributed on the basis of the percentage it bears to the direct expense (labor and material), but after the plant has started operating costs should not be "fooled" by charging

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every little item of further construction and changes around the plant with a portion of the overhead expense, as this would probably amount to the same if no construction work were being done.

OPENING THE BOOKS.

Two discoverers of a mining property, after having done a considerable amount of development work on it, thus proving up an ore body of sufficient importance to warrant the construction of a plant, have decided to incorporate a stock company whose capitalization is to be 250,000 shares at a par value of $1 each. They each take 25,000 shares of the stock at par and pay in $50,000 in cash, admit some friends and give them one share each, in order to have a board of directors, and against the remaining 200,000 shares deed the mining property to the corporation. Therefore, in order to enter the transaction on the books, credit the "capital stock" account through the cash book with $50,000 and through a journal voucher with $200,000, charging the "property" account with $200,000.

CASH BOOK AND CASH VOUCHER RECORD.

The forms for a cash book (see Form 1) and for a cash voucher record (Form 2) are simple. After making current payments during the month, all indebtedness should be vouchered and the vouchers entered in the voucher record, even though they are not to be paid until the next month. The "audited vouchers" account is credited with the total of all vouchers entered and charged from the cash book with all payments made. If you have entered more vouchers in the voucher record than you have paid during the month, the "audited vouchers" account in the ledger (p. 42) will show a credit balance which should consist of the total unpaid vouchers. A list should be made of the unpaid vouchers to see that the total agrees with the credit to "audited vouchers" account. By doing this, if you have drawn a check for more or for less than the voucher calls for the error will be detected immediately. Keep the unpaid vouchers in a separate file.

A voucher is a receipt and should show and have attached to it the invoice it pays and the canceled check paying it. Some bookkeepers file the supporting documents to a voucher separately, but if you expect to have your accounts audited and the auditor to be paid on a per diem basis it will be economy to attach to receipted vouchers the invoices or other documents paid, as a good auditor will wish to scrutinize them against the amount the voucher calls for.

The form of voucher (see Form 3) listing the payments on the inside, with the distribution on the back, is about as good as any devised; the canceled check paying the voucher should be filed with it when returned from the bank.

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FORM 1.—*Cash book record.*

Cash receipts.					Cash disbursements.					
Date.	Item.	Voucher No.	Amount.	Total (Dr.).	Date.	Item.	Check No.	Voucher No.	Charge vouchers.	Total (Cr.).
Jan. 1	*Capital stock*		*$50,000.00*		*Jan. 1*	*Allis Chalmers Co*	*1*	*1–1*	*$1,500.00*	
31	*Metals in transit*				*2*	*Bill Smith, time check No. 1*	*2*	*1–2*	*9.00*	
	Advance on lots 1–5		*8,000.00*		*3*	*Jones Hardware Co*	*3*	*1–3*	*175.00*	
					31	*Bell Telephone Co*	*4*	*1–4*	*18.00*	
						W. U. Telegraph Co	*5*	*1–5*	*14.00*	
						Giant Powder Co	*6*	*1–6*	*1,470.00*	
						Mrs. Getem	*7*	*1–15*	*50.00*	
						C. King	*8*	*1–16*	*500.00*	
						J. Brown	*9*	*1–17*	*250.00*	
						Tax collector	*10*	*1–18*	*1,200.00*	*$5,186.00*
										52,814.00
			58,000.00						*5,186.00*	*58,000.00*
						Bal. as per bank statement			*54,264.00*	
						Checks out—				
						No. 9 *$250*				
						No. 10 *1,200*				
									1,450.00	
						Bal. as per cash book			*52,814.00*	

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FORM 2.—*Cash voucher record.*

Date.	To whom paid.	Vo. No.	Miscellaneous credits.	Credit vouchers.	Distribution.					Miscellaneous.	
					Warehouse accounts.	Pay-roll accounts.	Administration.	Office expenses.	(a)	Account.	
Jan. 1	Allis-Chalmers Co.....	1		$1,500.00	$1,500.00						
4	Time check No. 1.....	2		9.00		$9.00					
	Jones Hardware Co.....	3		175.00	175.00						
31	Bell Telephone Co.....	4		18.00				$18.00			
	W. U. Tel. Co.....	5		14.00				14.00			
	Giant Powder Co.....	6		1,470.00	1,500.00						
	Discount.....		$30.00								
	Time check No. 2.....	7		50.00		50.00					
	Smith Bros. & Co.....	8		170.00	170.00						
	Brown Hardware Co.....	9		89.00	89.00						
	U. S. Steel Corporation...	10		1,800.00	1,800.00						
	American Paint Co.....	11		150.00	150.00						
	Hercules Hardware Co ...	12		4,000.00	4,000.00						
	Cook Lumber Co.....	13		5,000.00	5,000.00						
	S. P. R. R.....	14		675.00	675.00						
	Mrs. Getem.....	15		50.00				50.00			
	C. King, salary.....	16		500.00			$500.00				
	J. Brown, salary.....	17		250.00			250.00				
	Tax collector.....	18		1,200.00						1919 taxes ...	$1,200.00
	American Insurance Co...	19		600.00						Insurance....	600.00
	Town Water Co.....	20		100.00				25.00		Power (feed water).	75.00
			30.00	17,820.00	15,059.00	59.00	750.00	107.00			1,875.00

(a) Extra column for additional account if desired.

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FORM 3.—*Voucher.*

.....MINING CO.

Voucher No. .....

Check No. .....

Paid to.....

Address.....

Date.	Item.	Amount.	Total.

Reverse side (lower half of sheet.)

CHECK No. ..... VOUCHER No.....

Paid to.....

Distribution.	

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PAY ROLL.

Now that the books are opened, the next thing to decide on is the form of pay roll best adapted to the plant. If the labor force will be

FORM 4.—*Individual pay roll card.*[a]

Month of ....., 19....

Name..... **Occupation**.....**Rate**.....**No**.....

	Hours.	Overtime.	Amount earned.	Distribution.												
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
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26																
27																
28																
29																
30																
31																

Days worked at .... per day..... $.....

Board..... $.....

Hospital..... .....

Store..... ....

Balance..... ..... Check No.

[a] Distribution can be taken from these cards daily onto a "summary" sheet. At end of month make a summary of "amount earned," "shifts worked," "deductions," and "balance paid." File "summary" with all cards for month bound together.

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small, say, up to 150 or 200 men, and composed of reasonably intelligent men, daily time cards, showing the man's name, number, hours worked and where—these cards to be turned in to the foremen at the end of a shift and inspected and initialed by them—will give a good distribution and time record. For a small operation I have found the individual pay roll for each man (see Form 4) to work successfully. The daily time cards are entered on the pay-roll cards. The amounts in the distribution columns can be transferred daily onto large sheets, for the daily accumulation of the distribution and balanced against the total amounts earned and a daily "labor report" furnished the superintendent of departments, or the totals from pay-roll card columns can be accumulated at the end of the month.

At the end of a month a summary of pay-roll cards should be made, showing shifts worked, amounts earned, deductions, and balance paid. Most offices are equipped with an adding machine and this summary can be easily made. After the pay-roll cards are all paid, they should be bound together with the summary and filed away. Deductions from the monthly pay roll should be made out according to journal voucher No. 3–119.

Journal voucher for deduction from pay roll.

Journal Voucher. **No. *3–119*.**

Deductions from January pay rolls.

Taken into *January, 1919*, account:

Total roll		*$13,455.00*
Hospital	*$325.00*	
Board	*2,900.00*	
		3,225.00
Balance paid		*10,280.00*

	Sub. acct.	Folio No.	Dr.		Sub. acct.	Folio No.	Cr.
Pay roll acct			*$3,225.00*	*Hospital*			*$325.00*
				Boarding house			*2,900.00*

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After the monthly distribution of labor is arrived at, a journal voucher should be made, such as sheet No. 1–119, which signifies the first voucher in January, 1919. The first journal voucher in February, 1919, would be numbered No. 1–219.

Journal voucher for pay roll distribution.

Journal Voucher.[a] **No. *1–119.***

Taken into *January, 1919*, Accounts.

January pay roll distribution .....

.....

.....

	Sub. Acct.	Folio No.	Amount (Dr.).		Sub. Acct.	Folio No.	Amount (Cr.).
Mining	.....	.....	$4,155.00				
Breaking ore	$3,000.00						
Underground tramming	150.00						
Timbering	300.00						
Surface expense	75.00						
Sampling	100.00						
Hoisting	450.00						
Drill sharpening	80.00	.....	450.00				
Tramway	.....	.....	450.00				
Milling	.....	.....	2,500.00				
Ore bins, grizzlies, and conveyors	90.00						
Coarse crushing [b]	310.00						
Fine crushing [b]	310.00						
Elevators	40.00						
Concentrating [b]	1,400.00						
Tailings disposal	270.00						
General mill expense	80.00						
Power plant	.....	.....	930.00				
Boilers	360.00						
Feed-water supply	60.00						
Corliss engine	170.00						
Generator	170.00						
Compressor	170.00						
Assaying	.....	.....	360.00				
Stable expense	.....	.....	180.00				
General surface expense	.....	.....	90.00				
Blacksmith shop	.....	.....	150.00				
Machine shop	.....	.....	220.00				
Carpenter shop	.....	.....	150.00				
Warehouse expense	.....	.....	200.00				
Office expense	.....	.....	375.00				
Boarding house	.....	.....	300.00				
Hospital	.....	.....	250.00				
Development	.....	.....	2,040.00				
Drilling and blasting	1,080.00						
Tramming	270.00						
Timbering	360.00						
Sampling	90.00						
Hoisting	200.00						
Drill sharpening	40.00						
Machine shop expense	.....	.....	49.00				
Blacksmith shop expense	.....	.....	38.00				
Carpenter shop expense	.....	.....	18.00				
				Pay roll acct.	.....	.....	12,455.00
			12,455.00				12,455.00

[a] Sheet punched at top for binding.
[b] Divide into departments if operation is large enough.

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Journal voucher for supply distribution.

Journal Voucher. **No. *2–119.***

Taken into. ***January, 1919*, Accounts.**

January supply distribution. .....

.....

.....

	Sub-acct.	Folio No.	Amount (Dr.).		Sub-acct.	Folio No.	Amount (Cr.).
Lining			$912.00				
Breaking ore:							
Explosives	$450.00						
Drill parts	50.00						
Steel	60.00						
Other supplies	50.00						
Underground tram'g.	15.00						
Timbering	250.00						
Surface expense	8.00						
Sampling	6.00						
Hoisting	18.00						
Drill sharpening	5.00						
Tramway			16.00				
Milling:							
Coarse crushing a			655.00				
Wearing parts	75.00						
Other supplies	8.00						
Fine crushing a—							
Wearing parts	60.00						
Other supplies	16.00						
Elevators—							
Buckets	115.00						
Belts							
Other supplies	9.00						
Concentrating a—							
Wearing parts	300.00						
Other supplies	60.00						
Tailings disposal	7.00						
General mill expense	5.00						
Power plant			803.00				
Boilers—							
Fuel	600.00						
Other supplies	20.00						
Feed-water supply	6.00						
Corliss engine—							
Oils, grease, waste	70.00						
Other supplies	14.00						
Generator	10.00						
Compressor—							
Oils, grease, waste	70.00						
Other supplies	13.00						
Forward			2,386.00				

a Distribute into departments if operation is large enough.

WAREHOUSE.

About the third of the month, if the warehouseman has a proper system and has kept his work up he should hand to the office a "supply distribution" in form as per the information on journal voucher No. 2–119.

The "warehouse expense" account has been charged with the warehouseman's salary, and labor in the warehouse; also small supplies used around the warehouse. It has been found that the total issues of supplies divided into the total warehouse expense gives 0.03447 per

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Journal voucher for supply distribution—Continued.

	Sub-acct.	Folio No.	Amount (Dr.).		Sub-acct	Folio No.	Amount (Cr.).
Forwarded			$2,386.00				
Assaying			277.00				
Fuel	$90.00						
Chemicals	150.00						
Utensils	30.00						
Other supplies	7.00						
Stable expense			143.00				
Hay	75.00						
Grain	60.00						
Other supplies	8.00						
Blacksmith shop			321.00				
Steel	180.00						
Iron	97.00						
Fuel	26.00						
Other supplies	18.00						
Machine shop			115.00				
Steel	47.00						
Iron	28.00						
Hardware	15.00						
Tools	8.00						
Waste	7.00						
Oil	6.00						
Other supplies	4.00						
Carpenter shop			226.00				
Lumber and timber	200.00						
Tools	17.00						
Other supplies	9.00						
Warehouse expense			8.00				
Office expense			12.00				
Boarding house			2,000.00				
Hospital			50.00				
Development			466.00				
Drilling and blasting—							
Explosives	230.00						
Drill parts	25.00						
Steel	80.00						
Other supplies	25.00						
Tramming	8.00						
Timbering	125.00						
Sampling	7.00						
Development—Con	$450.00						
Hoisting	13.00						
Drill sharpening	3.00						
Machine shop expense			19.00				
Blacksmith shop expense			8.00				
Carpenter shop expense			11.00				
				Supplies			$6,042.00
			6,042.00				6,042.00

cent (see journal voucher No. 4–119). You will therefore increase your charges of supplies to each account by this percentage. To save posting this voucher separately it could be combined with No. 2–119.

You now have the main information with which to start your accounts for the month (distributions of "Labor" and "Material").

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Journal voucher for distribution of warehouse expense.

Journal Voucher. **No. *4–119.***

Distribution of warehouse expense:

Taken into *January* accounts.

$208 divided by total issues for January	$6,042
Less supplies charged to warehouse expense	8
	6,034

6,034 equals 0.03447 per cent.

	Sub. Acct.	Folio. No.	Amount (Dr.).		Sub. Acct.	Folio. No.	Amount (Cr.).
Mining			$31.44	*Warehouse expense*			$208.00
Breaking ore	$21.03						
Underground tramming	.52						
Timbering	8.63						
Sampling	.20						
Hoisting	.62						
Surface expense	.27						
Drill sharpening	.17						
Tramway			.55				
Milling			22.58				
Coarse crushing	2.86						
Fine crushing	2.62						
Elevators	4.28						
Concentrating	12.41						
Tailings disposal	.24						
General mill expense	.17						
Power plant			27.68				
Boilers	21.58						
Feed water	.20						
Corliss engine	2.89						
Generator	.35						
Compressor	2.86						
Assaying			9.54				
Stable expense			4.93				
Blacksmith shop			11.07				
Machine shop			3.98				
Carpenter shop			7.79				
Office expense			.40				
Boarding house			68.94				
Hospital			1.72				
Development			16.07				
Drilling and blasting	10.69						
Tramming	.27						
Timbering	4.33						
Sampling	.24						
Hoisting	.44						
Drill sharpening	.10						
Machine shop expense			.66				
Blacksmith shop expense			.27				
Carpenter shop expense			.38				
Total			208.00	*Total*			208.00

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JOURNAL VOUCHERS.

Many mining companies use what is called a "combined cash and journal voucher record." Such records are an abomination, for the reason that totals are posted from them to the ledger and in consequence the ledger accounts are meaningless. The items contained in a journal voucher have to be put down once somewhere and be totaled, so they may as well be entered in the ledger in the first instance and be totaled there. Then the ledger, which is supposed to reflect the outcome of a business, will then contain the required information, and there will be no necessity of first looking up an amount in the "combined cash and journal voucher record" and then getting the voucher itself out of the files to ascertain what the entry meant, in order to analyze a ledger account. To avoid this, post direct from the journal voucher to the ledger. The voucher sheet can be made of stout paper and if kept filed in a proper cover is just as good as the usual loose-leaf voucher record. Documents supporting the vouchers and bearing the number of the voucher to which they belong may be filed with them or separately, as desired.

After posting the pay roll and supply vouchers you will have opened in the ledger (see pp. 43 to 60) the necessary operating accounts. The main operations entering into the cost of production are "development," "mining," "tramway," and "milling." All other accounts are distributive and must be absorbed by the above four accounts.

The "sub-account" column in journal vouchers is for cost-sheet purposes and can be posted to a subsidiary ledger. However, this is not necessary, as monthly cost sheets should be made accumulative and kept in a permanent file.

SHOPS.

The first of the distributive accounts to deal with is the "shops" account, as the shops have probably done work chargeable to all of the other accounts. Then the contingency arises that the power plant furnished the shops with power, so that in order to arrive at the total charge to shops you must know how much to charge them with for power, and, on the other hand, the shops may have done some work entering into the cost of power furnished them. There is but one way to do this: Estimate the cost of power furnished to the shops and charge that to "blacksmith shop expense," "machine shop expense," and "carpenter shop expense" (journal voucher No. 5–119) After the plant has been running for a while, you can make a very close estimate of this amount and adjust the difference in the next month. To these shop expense accounts should also be charged wages of foremen, labor used in repairing shop machinery, etc., and supplies, such as oils, grease, waste, hacksaws, and other tools used in the shops

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Journal voucher for distributing power charges to shops.

Journal Voucher. **No. 5–119.**

Taken into *January* accounts.

Estimated power-station charges to shops:

Machine shop 4,500 kw. hours used, at 1¢	$45.00
Blacksmith shop, 2,500 kw. hours used, at 1¢	25.00
Total	70.00

	Sub. acct.	Folio No.	Amount (Dr.).		Sub. acct.	Folio No.	Amount (Cr.).
Machine shop			$45.00	*Power plant*			$70.00
Blacksmith shop			25.00	*Generator*	$70.00		
Total			70.00	*Total*			70.00

Journal voucher for transfer of shop expenses.

Journal Voucher. **No. 6–119.**

Taken into *January* accounts.

Transfer of shop expenses

	Sub. acct.	Folio No.	Amount (Dr.).		Sub. acct.	Folio No.	Amount (Cr.).
Machine shop (operation)			$68.66	*Machine-shop expense*			$68.66
Blacksmith shop (operation)			46.27	*Blacksmith-shop expense*			46.27
Carpenter shop (operation)			29.38	*Carpenter-shop expense*			29.38
Total			144.31	*Total*			144.31

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and not directly chargeable to any one job (see voucher No. 6–119. This is the shop overhead expense to be charged to jobs done. The shop clerk has kept an accurate job card (Form 5) for each job on which he has entered the labor and supplies used. You have a space on the card for "shop overhead." You find that the total labor charged to shop orders equals the labor charged to "shop operations." If not, the shop labor has not been properly distributed on the time cards. You find that the amount of material charged on shop orders equals that charged to shop operations. The total bears a certain percentage to the total charge to shop expense. Therefore, add that percentage to the total amount charged on each shop order for labor and supplies in the space for "shop overhead."

FORM 5.—*Job card.*

Work ordered by..... Job No.....

Nature of work.....

.....

.....

.....

.....

Charge to.....

Date.	Item.	Labor.	Material.	Overhead.	Total cost.

SHOP ORDERS.

Then make journal voucher No. 7–119 which will absorb the "shop operating" and "shop expense" accounts for the month.

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Journal voucher for distribution of shop accounts.

Journal Voucher. **No. 7–119.**

Taken into *January* accounts.

Distribution of shop accounts as per summary of shop job orders .....

	Sub. acct.	Folio No.	Amount (Dr.).		Sub. acct.	Folio No.	Amount (Cr.).
Mining			$120.00	*Machine shop*			$452.64
Breaking ore	$50.00			*Blacksmith shop*			553.34
Timbering	45.00			*Carpenter shop*			413.17
Sampling	10.00						
Hoisting	15.00						
Tramway			80.00				
Milling			900.00				
Coarse crushing	100.00						
Fine crushing	150.00						
Elevators	50.00						
Concentrating	500.00						
Tailings disposal	100.00						
Stable expense			19.15				
Power plant			300.00				
Boilers	100.00						
Corliss engine	75.00						
Generator	75.00						
Compressor	50.00						
Total			1,419.15	*Total*			1,419.15

POWER PLANT.

The next account to distribute will be "power plant." You find that "boilers and feed water" have been charged with a total of $1,242.58 for labor and material, etc. The master mechanic informs you that the heating plant used an eighth of the steam generated and the Corliss engine the balance.

Journal voucher for transfer of boiler and feed water costs.

Journal Voucher. **No. 8–119.**

Transfer of boiler and feed-water costs to Corliss engine power plant ....

	Sub. acct.	Folio No.	Amount (Dr.).		Sub. acct.	Folio No.	Amount (Cr.).
Power plant:				*Power plant:*			
Corliss engine	$1,242.58			*Boilers*	$1,101.38		
				Feed water	141.20		
Total	1,242.58			*Total*	1,242.58		

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On journal voucher No. 8–119 you will, in the subaccount columns, charge "Corliss engine" and credit "boilers and feed water" with this proportion of the labor and material.

To make a credit entry on this special form of ledger page, in the "item" column write "distribution of steam" and in red ink credit "boilers and feed water," charging "Corliss engine" in black ink.

The master mechanic informs you that the Corliss engine has generated a certain number of horsepower and of this the generator has used a certain number and the compressor a certain number. On journal voucher No. 9–119 make an entry to cover, crediting "Corliss engine" in red and charging "generator and compressor." The power from the generator will be used in operating motors and furnishing light to all parts of the plant, and the compressed air to operate mine drills, and perhaps for agitation or other purposes in the mill.

The distribution of the cost of power furnished by the generator will be on the basis of kilowatt-hours delivered and consumed by motors and electric lights. The electrician will give you the number of kilowatt-hours consumed by each, which you will multiply by the cost per kilowatt-hour you have arrived at. The mine foreman will give you the number of cubic feet of air consumed in mining and development, and the mill foreman the amount, if any, used in the mill. Multiply these figures by the unit cost per cubic foot, found by dividing the total cubic feet of air produced into the cost of operating the compressor.

You now have the basis for making a journal voucher distributing the total cost of power-house operating. (See journal vouchers Nos. 10–119 and 11–119.)

Journal voucher for distribution of Corliss engine charges.

Journal Voucher. **No. *9–119.***

Distribution of power-plant Corliss engine charges .....

	Sub. acct.	Folio No.	Amount (Dr.).		Sub. acct.	Folio No.	Amount (Cr.).
Power plant:				*Power plant:*			
Generator	$787.23			*Corliss engine*	$1,574.47		
Compressor	787.24						
Total	1,574.47						

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Journal voucher for distribution of generator charges.

Journal Voucher. **No. *10–119.***

Distribution of power-plant generator charges:

Generated 95,409 kw.-hours at 0.946¢ equals $902.58
Less 7,000 kw.-hours at 1.0¢ equals ..... 70.00 *charged to shops.*

88,409 kw.-hours at 1.1¢ equals 972.58

Kw.-hours.	Subacct.	Folio No.	Amount (Dr.).		Subacct.	Folio No.	Amount (Cr.).
Mining			$88.00	*Power plant*			$972.58
Hoisting 8,000	$88.00			*Generator*	$972.58		
Development			33.00				
Hoisting 3,000	33.00						
Milling			674.48				
Power 40,409	444.58						
Heating 12,500	137.50						
Lighting 8,400	92.40						
Stable expense 600			6.60				
Office expense 3,000			33.00				
Hospital 5,500			60.50				
Boarding house 7,000			77.00				
Total			972.58				

Journal voucher for distribution of compressor charges.

Journal Voucher. **No. *11–119.***

Distribution of power-plant compressor charges:

10,931 M cubic feet at 10¢ .....
.....
.....
.....

	Subacct.	Folio No.	Amount (Dr.).		Subacct.	Folio No.	Amount (Cr.).
Development (33 per cent)			$360.72	*Power plant*			$1,093.10
Drilling and blasting	$360.72			*Compressor*	$1,093.10		
Mining (67 per cent)			732.38				
Breaking ore	732.38						
Total			1,093.10				

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ASSAYING.

The next step is to distribute the assaying account. The assayer has kept a record of the number of assays made for the mining, development, mill, and outside people. The total cost divided by the total number of determinations gives the average cost of a single assay. This gives you the basis for making journal voucher No. 12–119 absorbing the assaying account.

Journal voucher for distribution of assaying.

Journal Voucher. **No. *12–119.***

Taken into *January* accounts.

Distribution of assaying:

Assays made during the month for:

Mining department	*1,800 at 20.204¢*	*$363.68*
Milling department	*800 at 20.204¢*	*161.63*
Development	*600 at 20.204¢*	*121.23*
Total	*3,200*	*646.54*

	Subacct.	Folio No.	Amount (Dr.).		Subacct.	Folio No.	Amount (Cr.).
Mining			*$363.68*	*Assaying*			*$646.54*
Milling			*161.63*				
Development			*121.23*				
Total			*646.54*				*646.54*

STABLE.

The plant owns two wagons and two teams, and employs two drivers for hauling material to and from the warehouse to the mine and mill and for working around the surface. You have charged the "stable" account with the labor of drivers and supplies for feeding horses and possibly have some charges from "blacksmith shop" and "machine shop" for shoeing horses, repairing wagons, etc. In a 30-day month with four horses there are 120 horse-days. The 120 horse-days divided into the total charge to stable account gives the basis for making journal voucher No. 13–119 the teamsters having reported on cards each day just where they were hauling and the time expended on each job.

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Journal voucher for distribution of stable expense.

Journal Voucher. **No. *13–119.***

Distribution of stable expense, as per summary of daily time sheets:

120 horse-days at $2.94⅞ per day.....

.....

.....

.....

	Subacct.	Folio No.	Amount (Dr.).		Subacct.	Folio No.	Amount (Cr.).
Mining (50 horse-days)...	.....	.....	*$147.36*	*Stable expense*.....	.....	.....	*$353.68*
Stable expense.....	*$147.36*						
Milling (60 horse-days)...	.....	.....	*176.84*				
Stable expense.....	*176.84*						
General surface expense (5 horse-days).....	.....	.....	*14.74*				
Office expense (5 horse-days).....	.....	.....	*14.74*				
Total.....	.....	.....	*353.68*				

DEVELOPMENT.

Development is work done in seeking for ore bodies and putting them in shape to mine. The cost of development work is a part of the cost of mining, but the total amount expended in such work during any one month is rarely chargeable to that month's costs. Usually before a mine starts to produce ore, or before a milling plant is constructed, sufficient development work is done to assure a supply of ore for immediate mining. As the ore is being mined after operations start, the development work progresses so as always to insure a supply of ore. It is learned from the mine superintendent that the amount expended in development has exposed and made ready for mining a certain tonnage of ore. This tonnage divided into the amount expended gives the factor for adding to mining costs on the basis of tons of ore mined.

Perhaps at the start an expensive shaft is sunk or a main adit tunnel run. This shaft or tunnel has exposed or developed no ore, but the development has started from the bottom of the shaft or the end of the main tunnel. The shaft or tunnel is to be used as the main exit for all ore mined during the life of the mine. It is determined by engineers that the mine has a probable life of 10 years at

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an output of 36,000 tons a year. The proper way to dispose of the cost of this shaft or tunnel would be to divide it by 360,000, giving a factor per ton to add to each ton of ore mined, in addition to the regular development cost per ton, which should be changed from time to time as development progresses, based on the ore developed.

You now have the basis for journal voucher No. 14–119 charging "mining operations" with its proportion of development.

Journal voucher for distribution of development costs.

Journal Voucher. **No. *14–119.***

Development:

Development at 25¢ per ton of ore mined......

.....

.....

.....

	Subacct.	Folio No.	Amount (Dr.).		Subacct.	Folio No.	Amount (Cr.).
Mining.....		.....	*$750.00*	*Development*.....	.....	.....	*$750.00*
Development.....	*$750.00*						

COST AT MILL OF CONCENTRATES PRODUCED.

During the month of January the mill has treated only 2,500 tons of the total of 3,000 tons of ore mined. If in the "profit and loss" statement (p. 35) for the month the total mining cost, also the milling and other costs, are charged against receipts from production sold, the statement would simply show that receipts over expenditures were a certain amount. Therefore, in order to get the exact profit or loss for the month charge the mill with the ore it used at the rate per ton it cost to mine and transport the ore. This will give the basis for journal voucher No. 15–119 charging "milling" and crediting "mining" and "tramway" with the cost of the ore used.

Perhaps during development work or shaft sinking, some milling ore has been mined and sent to the mill. "Development," or "shaft sinking," has been charged with the cost of breaking this ore and

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should receive credit for it at a rate per ton based on previous mining costs per ton, and the "milling" account charged with it along with the other ore milled.

Journal voucher for mining and tramming costs of ore milled.

Journal Voucher. **No. *15–119.***

Mining and tramming cost of ore milled.....
.....
.....
.....

	Subacct.	Folio No.	Amount (Dr.).		Subacct.	Folio No.	Amount (Cr.).
Milling.....	.....	.....	*$6,629.77*	*Mining—2,500 tons, at $2.433*.....	.....	.....	*$6,085.22*
				Tramway—2,500 tons, at $0.218.....	.....	.....	*546.55*
				Total.....	.....	.....	*6,629.77*

DEPRECIATION.

As soon as the plant has started to operate it has commenced to wear out. A reserve should therefore be set up, which at the expiration of the estimated life of the plant will be sufficient to replace it. The longevity of a mining plant as a whole, is a matter of estimate, usually based on the life of the known ore body. Make a schedule of the items entering into the construction and equipment of the plant. The plant buildings are probably so constructed that with ordinary repairs they will last as long as the ore supply, which has been estimated at, say, 15 years. Divide the cost of these buildings by 15 to arrive at the depreciation per year and that amount by 12 to arrive at the monthly charge to operating costs. Engineering experience will show that the machinery, belting, and other equipment of the plant will not have as long a life, and the monthly depreciation of equipment should be figured accordingly.

A great many plants do not take depreciation into their operating costs unless they have a profit to charge it against. This is poor practice, as the minute a plant starts to operate the wearing of it is part of the cost of operations.

The Government requires in connection with the deduction of depreciation on tax returns that after a plant has started to charge

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depreciation as part of its costs only ordinary repairs shall be charged to current operating expense. Actual replacements are to be charged to the depreciation reserve which has been set up, as in setting up this reserve an amount sufficient to cover the replacement is supposed to have been charged to operations. It is therefore necessary to have your schedule for depreciation in such form that you may at all times know just what the reserve contains.

Depreciation on equipment in use during the construction period and before operations are commenced may be charged to a deferred account. This in turn will be charged to profit and loss, prorated over the estimated life of the property after the plant has begun operating.

OBSOLESCENCE.

After the plant has been operating for some time, some of the machinery will probably be found unsuitable and have to be replaced by another type. The discarded machines may be nearly worn out and therefore have little salvage value. Charge the cost of the new machinery to the "construction and equipment" account and add it to the "depreciation schedule," figuring the life of the machinery from the date it starts work. The cost of the replaced machinery less the depreciation already deducted and less any salvage value it may have is the amount you are permitted to charge to "profit and loss" as a loss. This item can only be taken in as a loss against the profits made in the year when the machinery was discarded.

DEPLETION.

All mines are wasting assets, their value is based on the mineral they contain; therefore as the ore is mined their value is depleting. The manner of arriving at a basis for deducting depletion from income is a study in itself, especially if the mine has been working several years and the company has only now commenced to consider the deduction. If the company is operating a copper mine, the unit which is being taken from the mine and therefore depleting or reducing its value, is the pound of copper. Therefore the value of a pound of copper in the mine before extraction must be determined. Suppose your company purchased the mine on an engineer's report estimating that it contained 500,000 tons of 2.5 per cent copper, or 25,000,000 pounds, and paid $250,000 for the property. If this transaction occurred in, say, the year 1918, and the company started mining in 1918 or 1919, you could figure the depletion deduction at 1 cent per pound for every pound mined during the life of the mine. However, if the mine has been in operation for several years it would be well for the management to consult the Bureau of Internal Revenue and get all its rulings, as the published regulations on this subject are still unsettled.

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TRIAL BALANCE.

As the accounts on the ledger will be practically the same each month, it will be well to get a trial balance book and save the trouble and time necessary to rewrite the account names each month. This book is also useful for comparative purposes in case the ledger does not balance.

After taking off the trial balance, you are ready to make out the "cost sheet" and the "profit and loss" statement (pp. 33 to 35).

SPECIMEN TRIAL BALANCE.

Balance sheet.

January 31, 1919.

Assets:		
Cash		$52,814.00
Accounts receivable—		
Metals in transit		14,500.00
Ore in bins		1,216.64
Warehouse materials and supplies		9,017.00
Deferred accounts—		
Hospital		37.22
Prepaid operating—		
Development		2,287.02
Construction and equipment	——	——
Less reserve for depreciation	——	——
Property		200,000.00
Total assets		279,871.88
Liabilities:		
Accounts payable—		
Audited vouchers	$12,634.00	
Pay roll	9,171.00	
Freight and treatment	875.00	
		22,680.00
Notes payable		——
Deferred credits—		
Boarding house		454.06
Bonds payable		——
Capital stock		250,000.00
Earned surplus—		
Sales—		
Copper	20,000.00	
Gold	1,240.20	
Silver	1,259.80	
Total sales	22,500.00	
Costs—		
Concentrates shipped $14,917.18		
Freight and treatment 875.00		
Total costs	15,792.18	
Profit on sales	6,707.82	
Miscellaneous income—		
Purchase discounts	30.00	
Total earned surplus		6,737.82
Total liabilities		279,871.88

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COST SHEET AND PROFIT AND LOSS STATEMENT.

By this time you have received from the heads of the different departments the monthly tonnage figures or they have been received by you daily and accumulated. You have been given the assay of the average "mill heads" (ore milled) and concentrates produced during the month. The plant being a small one, with no facilities for weighing a car, shipments are to be made on estimated weights and the weights of the smelter to which the concentrates are shipped taken as final, as is also the smelter assay for the grade of the product. You have entered on the "shipping and metal record" (see Form 6) the settlement figures from the smelter and also, for the sake of comparison, the assays and estimated weights of the company.

The company's contract with the smelter calls for payments to be made on shipments 60 or 90 days after their receipt, or after date of weighing and assaying, on the basis of market value of the metals contained, on the date of settlement.

If you wait until the settlements from the smelter have all been received covering any one month before you figure the profit for that month you will always be behind two or three months in your statement.

As soon as shipments are weighed and assayed the smelter should send the company these figures, which you can enter in the "shipping and metal record," computing the pounds or ounces of metal produced. Estimate the gross amount the company will receive per pound or per ounce of metal produced and enter the total value in the "estimated value" column in the "shipping and metal record." Open in the ledger accounts called "metals in transit" and "metal sales." Debit "metals in transit" (see journal voucher No. 16–119) with the amount you have entered in the "shipping and metal record" under "estimated value" and credit the "metal sales" account. There will also be freight and treatment charges by the smelter to be taken care of. Estimate the amount of these charges and enter it in a column in the "shipping and metal record," then open up a "freight and treatment payable" (see journal voucher No. 17–119) account in the ledger, also a "freight and treatment" account, which you will charge with the estimated amount, crediting the "freight and treatment payable" account (see "Ledger," pp. 49 and 50).

As settlements are made by the smelter enter them in the "shipping and metal record" in the columns provided for actual returns. You have the estimated amounts and must adjust the differences. The checks received from the smelter will be credited through the cash book to "metals in transit." You will then have the basis for journal voucher No. 18–219 (p. 35), making the adjusting entries between estimated and actual figures, but as none of these smelter settlements have been received in January this journal voucher will be a February entry.

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FORM 6.—*Shipping and metal record.*

(LEFT-HAND PAGE.)

Date shipped.	Lot No.	Smelter lot No.	Date settlement is due.	Our assay.						Contents based on our assay.			Estimated value.				Estimated cost of freight and treatment.
				Cu, %	Au, ozs.	Ag, ozs.	Fe, %	CaO, %	SiO_2, %	Cu, pounds.	Au, ozs.	Ag, ozs.	Cu.	Au.	Ag.	Total.	

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(RIGHT-HAND PAGE.)

Estimated net value.	Smelter assays.						Contents.			Smelter returns.				Freight and treatment.	Miscellaneous.	Net return.	Differences adjusted.				
	Cu, %	Au, ozs.	Ag, ozs.	Fe, %	CaO, %	SiO_2, %	Cu, pounds.	Au, ozs.	Ag, ozs.	Copper.	Gold.	Silver.	Total.				Vo. No.	Cu,	Au,	Ag,	Freight and treatment.

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Journal voucher for estimated sales value of shipments to smelter.

Journal Voucher. **No. *16–119.***

Taken into *January* Accounts.

Estimated sales value of production shipped .....

.....

.....

.....

	Sub. acct.	Folio No.	Amount (Dr.).		Sub. acct.	Folio No.	Amount (Cr.).
Metals in transit.....	.....	.....	*$22,500.00*	*Copper sales*.....	.....	.....	*$20,000.00*
				Gold sales.....	.....	.....	*1,240.20*
				Silver sales.....	.....	.....	*1,259.80*
				Total.....	.....	.....	*22,500.00*

Journal voucher for estimated freight and treatment charges on products shipped to smelter.

Journal Voucher. **No. *17–119.***

Taken into *January* Accounts.

Estimated freight and treatment on production shipped .....

.....

.....

.....

	Sub. acct.	Folio No.	Amount (Dr.).		Sub. acct.	Folio No.	Amount (Cr.).
Freight and treatment.....	.....	.....	*$875.00*	*Freight and treatment payable*.....	.....	.....	*$875.00*

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COST SHEET AND PROFIT AND LOSS STATEMENT.

Cost sheet, January, 1919.

	This month.		Year to date.	
	Amount.	Per ton of ore.	Amount.	Per ton of ore.
Mining:				
Tons, this month, 3,000.				
Tons, year to date, ...				
Breaking ore—				
Labor	$3,000.00			
Explosives	450.00			
Drill parts	50.00			
Steel	60.00			
Other supplies	71.03			
Air	732.38			
Drill sharpening	85.17			
Shop orders	50.00			
Total	4,498.58			
Underground tramming—				
Labor	150.00			
Supplies	15.52			
Shop orders	.....			
Total	165.52			
Timbering—				
Labor	300.00			
Timber	250.00			
Other supplies	8.63			
Shop orders	45.00			
Total	603.63			
Sampling—				
Labor	100.00			
Supplies	6.20			
Shop orders	10.00			
Total	116.20			
Hoisting—				
Labor	450.00			
Supplies	18.62			
Power	88.00			
Shop orders	15.00			
Total	571.62			
Proportion of development—				
Tons of ore, at 25 cents per ton	750.00			
Assaying	363.68			
Stable expense	147.36			
Surface expense	83.27			
Total mining	7,299.86			
Tramway:				
Tons, this month, 2,500.				
Tons, year to date, ...				
Labor	450.00			
Supplies	16.55			
Shop orders	80.00			
Total	546.55			

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Cost sheet and profit and loss statement—Continued.

	This month.		Year to date.	
	Amount.	Per ton of ore.	Amount.	Per ton of ore.
Milling:				
Tons, this month, 2,500.				
Tons, year to date, ...				
Cost of mining and tramming 2,500 tons of ore, at $2.65191 per ton	6,629.77			
Ore bins, grizzlies, and conveyors—				
Labor	90.00			
Supplies	.....			
Shop orders	.....			
Total	90.00			
Coarse crushing—				
Labor	310.00			
Wearing parts	75.00			
Other supplies	10.86			
Shop orders	100.00			
Total	495.86			
Fine crushing—				
Labor	310.00			
Wearing parts	60.00			
Other supplies	18.62			
Shop orders	150.00			
Total	538.62			
Elevators—				
Labor	40.00			
Buckets	115.00			
Bolts	.....			
Other supplies	13.28			
Shop orders	50.00			
Total	218.28			
Concentrating—				
Labor	1,400.00			
Wearing parts	300.00			
Other supplies	72.41			
Shop orders	500.00			
Total	2,272.41			
Tailings disposal—				
Labor	270.00			
Supplies	7.24			
Shop orders	100.00			
Total	377.24			
Power	444.58			
Assaying	161.63			
Heating	137.50			
Lighting	92.40			
Stable expense	176.84			
General mill expense	85.17			
Total cost at mill of concentrates **produced**	11,720.30			
Overhead expense:				
Administration	750.00			
Office expense	542.14			
General surface expense	104.74			
Insurance	600.00			
Taxes	1,200.00			
Depreciation	.....			
Depletion	.....			
Total cost of concentrates produced	14,917.18			

Tons of ore milled	2,500
Percentage of Cu. in ore milled	3%
Pounds of Cu. in ore milled	150,000
Tons of concentrates produced	250
Percentage of Cu. in concentrates	24%
Pounds of Cu. in concentrates	120,000
Ratio of concentration	10 to 1
Percentage of recovery	80
Tons of ore milled per day	83.3

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Profit and loss, month of January, 1919.

	This month.		To date.	
	Quantity.	Amount.	Quantity.	Amount.
Pounds Cu. in concentrates produced	120,000			
Less smelter deductions	2,500			
Smelter returns for copper	117,500	$20,000.00		
Ounces silver in concentrates produced	1,259.8	1,259.80		
Ounces gold in concentrates produced	60	1,240.20		
		22,500.00		
Less freight and treatment charges		875.00		
		21,625.00		
Cost of concentrates produced		14,917.18		
Profit on concentrates produced		6,707.82		
Production cost		14,917.80		
Less realized from Ag. and Au		2,500.00		
Cost of copper produced		12,417.80		
Cost per pound paid for		10.56		

Journal voucher for adjusting concentrate shipments against smelter returns.

Journal Voucher. **No. *18–219.***

Taken into *February, 1919* Account.

Adjustment of following lots of concentrates shipped against smelter returns:

Lot No.	Estimated value.	Smelter value.	Difference adjusted.	Estimated freight and treatment.	Actual freight and treatment.	Difference adjusted.
1	*$7,000.00*	*$7,125.00*	*$125.00*	*$120.00*	*$125.00*	*$5.00*
2	*6,500.00*	*6,600.00*	*100.00*	*115.00*	*118.00*	*3.00*
3	*7,200.00*	*7,300.00*	*100.00*	*130.00*	*132.00*	*2.00*
4	*6,800.00*	*7,000.00*	*200.00*	*110.00*	*120.00*	*10.00*
5	*7,300.00*	*7,356.00*	*56.00*	*121.00*	*132.00*	*4.00*
	34,800.00	*35,381.00*	*581.00*	*603.00*	*627.00*	*24.00*

	Sub. acct.	Folio No.	Amount (Dr.).	Item.	Folio No.	Sub. acct.	Amount (Cr.).
Metal in transit			*$581.00*	*Copper sales*			*$581.00*
Freight and treatment			*24.00*	*Freight and treatment payable*			*28.00*
Freight and treatment payable			*627.00*	*Metals in transit*			*627.00*

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WAREHOUSE KEEPING.

A hardware store would not think of giving material away or letting people come in and help themselves, walking out with the article without paying.

A mine warehouse should be run exactly like a hardware store, except that in the warehouse the material is sold on a credit basis at cost plus a handling charge. The general office has charged the warehouse with everything in it. At the end of the month when the warehouseman makes a report of sales and to whom sales were made (the department requisitioning the material), the general office credits the warehouse with the amount sold and expects the warehouseman at all times to have on hand sufficient stock to cover the debit to its account. Therefore if the warehouseman has been careless and permitted employees to help themselves or has released stock and made no charge for it, there will not be enough stock on hand when an inventory is taken to cover the debit to "warehouse" account on the general books and the operating and construction accounts will not be correct.

At a mine where stocks of lumber, iron, steel, pipe, and coal are not inclosed or under cover, instructions by the management that anyone taking material without first giving the warehouseman a proper requisition will be summarily discharged will have a tendency to prevent shortages. If shortages in warehouse stock and the consequent loading of operating and construction costs with amounts prorated from these shortages, are to be taken as a matter of course, there is no use making detailed monthly cost sheets, for if the proper amount of supplies has not been charged, the costs figures are worthless.

There are many ways of keeping warehouse books but it is generally conceded that the perpetual inventory "stock card" or" stock book" is the best. This requires keeping a debit and credit account for each article in the warehouse. When an article comes into the warehouse and has been charged to "warehouse" by the general office, enter it on a suitable stock card or stock ledger page, showing date of receipt, from whom purchased, number of units, amount of invoice, amount of freight or express, total cost and price per unit. When this article is drawn from the warehouse the card or stock ledger sheet should show on the credit side the date it was issued, to what account charged, requisition number, and amount.

The requisitions should be numbered, and, after being entered on the stock card, should be listed on a large sheet of columnar paper, the columns being headed with the names of the accounts using the material. The total of the columns in the sheet should equal the total credits in the stock book and be the basis for journal voucher 2–119 (p. 14), after adding the percentage of warehouse expense.

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Form 7 shows the "stock card" or "stock book" page, and Form 8, the "foreman's order or requisition" for supplies.

FORM 7.—*Stock card.*[a]

MACHINE OIL.

Unit, *gals.*

Date.	Purchased from or issued to—	Receipts.					Issues.		Balance.		Unit cost.
		Amt. of invoice.	Freight and express.	No. of units.	Amt.	Req. No.	No. of units.	Amt.	No. of units.	Amt.	
Jan. 5	Texas Oil Co	$98.00	$2.00	200	$100.00						$0.50
7	Machine shop						10	$5.00	190	$95.00	
11	Concentrator						120	60.00	70	35.00	
15	Standard Oil Co	44.00	1.00	100	45.00				170	80.00	.4735
20	Corliss Engine						20	9.47	150	70.53	

[a] Punched on left margin for binding.

FORM 8.—*Warehouse requisition.*[a] **No.** .....

Please deliver to ..... the material listed
Below and charge same as shown .....
(Signature) .....
(Title.)
....., 1919.

Units.	Item.	Charge to—	Cost per unit.	Amount.

[a] To be bound in cardboard-covered books, original perforated for tearing out, duplicate on different-colored paper to remain in book.

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CONSTRUCTION COSTS.

First. Ascertain from the man in charge of construction work the details of the costs he will require and prepare a cost statement in tabulated form (preferably blue prints).

Second. Furnish the timekeeper, warehouseman, and foreman with a blue print of this cost detail and instruct them in charging the various accounts.

Third. In the ledger (pp. 43 to 60) open accounts to cover cost details, using the columnar ledger pages, with columns to carry the subaccounts, such as the following:

Mill building.

1918.	Voucher No.	Excavation.	Foundation.	Steel erection or framing.	Flooring.	Siding.	Overhead.	Total.
August pay roll distribution..								
August supply distribution...								
August overhead proportion..								

Machinery and installation (milling).

1918.	Voucher No.	Blake crusher.	Rolls.	Elevators.	Marcy mill.	Dorr classifier.	Etc.	Total.
August pay roll distribution..								
August supplies (machines)..								
August supplies (belting).....								
August supplies (shafting)....								
August supplies (motors).....								
August supplies (motors).....								
Overhead proportion.....								

Some bookkeepers will say that such a statement is in too much detail to go onto a ledger. Remember that if you are to keep this detail it has to go down onto paper somewhere, and it may as well be in the ledger, then in after years when you are gone, the information will be available.

Should you wish to credit any of the accounts, do so in red ink.

After the construction is finished you can make a summary showing total labor, supplies, etc., charged to each item of construction.

When you are trying to straighten out a warehouse shortage, you will find these detail ledger accounts useful. All machinery pur-

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chased should go through the "supply" account. If in checking up a shortage you should find under "machinery and installation in the mill," that in the "Blake crusher" column there was no charge for machines, you will find part of the shortage.

This form of construction and equipment ledger page will also be useful in making a depreciation schedule or in looking up the cost of a piece of machinery you wish to charge to "obsolescence."

Such a statement can in a large plant be carried in a subledger with the controlling account "construction and equipment" in the general ledger.

Other construction and equipment accounts should be kept as outlined above.

EXPANDING THE SYSTEM AND ADAPTING IT TO DIFFERENT CLASSES OF MILLING OR TO THE ADDITION OF A SMELTING AND CONVERTING PLANT.

The methods of keeping costs presented in the foregoing pages are intended for a small plant in which the operating force is not large—for instance, where one man per shift can handle the tramway terminal, trip buckets, and keep the grizzly clear; one man can attend to the coarse crusher and grinding machines; and a couple of men attend to the jigs, tables, vanners, or other concentrating machinery; and it is not feasible to divide their time. If, however, the plant is a large one and the management wishes to keep costs of operating the different classes of machines in each department, the only change necessary in this cost system is to so distribute the pay roll and supplies as to cover whatever detail costs is desired.

If the operation is a cyaniding process, instead of the caption "concentrating" in the cost sheet, you would have "cyaniding," with supplies subdivided into "cyanide," "lime," etc.; "filtering," "precipitating," with "zinc dust" or "zinc shavings" as the main supply item; and "refining."

If in the treatment of sulphide ores, oil flotation is a part or all of the process, changes can be made accordingly and the main supplies—oils, sulphuric acid, etc.—shown separately.

SMELTING AND CONVERTING.

If a smelting and converting plant is contemplated in addition to any of the processes mentioned, following the costs down to the cost per unit of finished product is a simple matter.

You have arrived at the cost of producing a ton of concentrate, or the metal contained therein, by charging the mill with the cost of mining and transporting to the mill the ore treated, in addition to the milling cost. Charge the smelting and converting operations

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with the cost at the mill of the concentrates smelted, which will give the cost per pound of finished metal produced after taking into consideration at the end of each month the inventories of metal in process, such as matte not yet converted and converter slag and flue dust to be resmelted. The total smelting and converting operations are to be credited with the cost of this copper in process at its different stages of completion; a "copper in process" account is to be debited. This account must be watched closely to see that the balance in it is representative of the actual inventory of copper in process, and adjustments made from time to time. It is very important that you familiarize yourself with the subject of "copper in process" and be able to form your own ideas as to a conservative estimate of the number of tons in a pile or bin of matte, converter slag, or flue dust, and keep in close touch with the sampling and assaying of such materials. The wisdom of this procedure is obvious, because if such matters are left entirely to the superintendent or furnace foreman they are prone to furnish figures which make the most favorable showing as to general metallurgical results.

It will be correct to carry in the "copper in process" account an amount representing the copper aways in process, tied up in blast furnace "sows" or reverberatory furnace bottoms.

Some smelting plants disregard the cost of copper in process on the theory that it averages about the same at the end of each month, but there are contingencies which may arise even at a small plant where it is necessary to take this factor into consideration in order to get a correct monthly cost. For instance, at a blast furnace and converting plant making copper let it be assumed that about the 29th of a month something happens to the power plant before the blowing of a charge in the converter is finished, and it is necessary to pour white metal (copper just under the completely blown point). At the same time the settlers are full of matte and have to be tapped, as the power repair will take several days. If you did not make some estimate of the white metal and matte in process and only took the amount of blister copper produced into consideration as against the total operating expense, the cost per pound for that month would mean nothing.

Form 9 gives an idea of what a cost sheet should be to cover a smelting and converting operation, to be used as a continuation of the mining and milling cost report; overhead charges to be included after arriving at the direct cost of mining, milling, smelting, and converting.

Form 10 shows the metallurgical results of the smelting and converting operations, the number of pounds of metal, and the cost thereof entering into the "copper in process" account.

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FORM 9.—*Cost sheet to cover smelting and converting operations.*

Blast furnace.	This month. Amount.	Per ton charged.	Per ton concts.	Per pound Cu.	Year to date.
..... tons of concentrates smelted at ..... cents per ton cost at mill.					
In process beginning month.					
Feed floor:					
Unloading and bins—					
Labor					
Supplies					
Shop orders					
Total					
Feeding—					
Labor—					
Charge wheelers					
Feeders					
Other labor					
Supplies—					
Coke					
Lime rock					
Shop orders					
Total					
Furnace floor:					
Labor					
Supplies—					
Jackets					
Spouts					
Tuyères					
Steel					
Other supplies					
Clay					
Silica lining					
Shop orders					
Assaying					
Power					
Water supply					
Lighting					
Total blast furnace					

	Amount.	Per ton matte.	Per pound cu.	Year to date.
Converting:				
Operating labor				
Supplies				
Shop orders				
Lining:				
Labor				
Brick (or silica)				
Supplies				
Shop orders				
Power				
Lighting				
Assaying				
Total converting				
Weighing, loading, shipping				
Total blast furnace and converting (including cost of ore mined which was milled and cost of milling)				

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FORM 10.—*Metallurgical data sheet.*

	This month.		Year to date.	
	Amount.	Cost.	Amount.	Cost.
Tons concentrates smelted				
Average assay				
Pounds of Cu on concentrates smelted				
Pounds of Cu in process beginning month, treated during month:				
In matte				
In converter slag				
In flue dust				
In white material				
In scrap				
Total copper to account for				
Copper produced during month				
Balance: Copper in process at end of month:				
In matte				
In converter slag				
In flue dust				
In white metal				
In scrap				
Copper lost in slag and flue dust				
Per cent coke to concentrates smelted				
Per cent coke to charge smelted				
Per cent lime rock to concentrates smelted				
Per cent lime rock to charge smelted				
Pounds copper lost				
Per cent smelting and converting loss				
Per cent total plant recovery				

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LEDGER.

Administration.

Date.	Item.	Folio No.	Amount (Dr.).	Date.	Item.	Folio No.	Amount (Cr.).
(1919.) Jan. 31	.....	V-1	$750.00	(1919.)			

Assaying.

Date.	Item.	Voucher No.	Amount (Dr.).	Date.	Item.	Voucher No.	Amount (Cr.).
(1919.) Jan 31	*January pay roll distribution*	1-119	$360.00	(1919.) Jan. 31	*Distributed*	12-119	$646.54
	January supplies:						
	Fuel	2-119	90.00				
	Chemicals	.....	150.00				
	Utensils	.....	30.00				
	Other supplies	.....	7.00				
	Warehouse expense	4-119	9.54				

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Audited vouchers.

Date.	Item.	Folio No.	Amount (Dr.).	Date.	Item.	Folio No.	Amount (Cr.).
(1919.) Jan. 31	.....	C-1	$5,186.00	(1919.) Jan. 31	.....	V-1	$17,820.00

Blacksmith shop (operating).

Date.	Item.	Voucher No.	Amount (Dr.).	Date.	Item.	Voucher No.	Amount (Cr.).
(1919.) Jan. 31	*January pay roll distribution*	1-119	$150.00	(1919.) Jan. 31	*Distributed*	7-119	$553.34
	January supplies:						
	Steel	2-119	180.00				
	Iron	.....	97.00				
	Fuel	.....	26.00				
	Other	.....	18.00				
31	*Warehouse expense*	4-119	11.07				
31	*Blacksmithshop expense*	6-119	46.27				
31	*Power used*	5-119	25.00				

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Blacksmith shop expense.

Date.	Item.	Voucher No.	Amount (Dr.).	Date.	Item.	Voucher No.	Amount (Cr.).
(1919.)				(1919.)			
Jan. 31	January pay roll.....	1-119	$38.00	Jan. 31	Transfer.. ..	6-119	$46.27
31	January supplies.....	2-119	8.00				
31	Warehouse expense....	4-119	.27				

Boarding house.

Date.	Item.	Voucher No.	Amount (Dr.).	Date.	Item.	Voucher No.	Amount (Cr.).
(1919.)				(1919.)			
Jan. 31	January pay roll.....	1-119	$300.00	Jan. 31	Pay roll deductions ..	3-119	$2,900.00
31	January supplies.....	2-119	2,000.00				
31	Warehouse expense....	4-119					
31	Light.....	10-119					

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Capital stock.

Date.	Item.	Folio No.	Amount (Dr.).	Date.	Item.	Folio No.	Amount (Cr.).
(1919)				(1919.) Jan. 31	.....	C-1, J	$50,000.00 200,000.00

Carpenter shop (operating).

Date.	Item.	Voucher No.	Amount (Dr.).	Date.	Item.	Voucher No.	Amount (Cr.).
(1919.) Jan. 31	January pay roll distribution.	1-119	$150.00	(1919.) Jan. 31	Distributed.....	7-119	$413.17
	January supplies:						
	Lumber and timber	2-119	200.00				
	Tools.....	.....	17.00				
	Other supplies....	.....	9.00				
31	Warehouse expense....	4-119	7.79				
31	Carpenter shop expense	6-119	29.38				

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Carpenter shop expense.

Date.	Item.	Voucher No.	Amount (Dr.).	Date.	Item.	Voucher No.	Amount (Cr.).
(1919.)				(1919.)			
Jan. 31	January pay roll.....	1-119	$18.00	Jan. 31	Transfer.....	6-119	$29.38
31	January supplies.....	2-119	11.00				
31	Warehouse expenses...	4-119	.38				

Cash.

Date.	Item.	Folio No.	Amount (Dr.).	Date.	Item.	Folio No.	Amount (Cr.).
(1919.)				(1919.)			
Jan. 31	.....	C-1	$58,000.00	Jan. 31	.....	C-1	$5,186.00

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Copper sales.

Date.	Item.	Voucher No.	Amount (Dr.).	Date.	Item.	Voucher No.	Amount (Cr.).
				(1919.) Jan. 31	.....	16-119	$20,000.00

Property.

Date.	Item.	Folio or voucher No.	Amount (Dr.)	Date.	Item.	Folio or voucher No.	Amount (Cr.).
(1919.) Jan. 31	Capital stock.....	J	$200,000.00	(1919.)			

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Development.

Date.	Account.	Vo. No.	Drilling and blasting.	Tramming.	Timbering.	Sampling.	Hoisting.	Drill sharpening.	Assaying.	Total. (Dr.).
(1919.)										
Jan. 31	Pay roll dist.....	1-119	$1,080.00	$270.00	$360.00	$90.00	$200.00	$40.00	.....	$2,040.00
31	Supplies.....	2-119	25.00	8.00	125.00	7.00	13.00	3.00	.....	466.00
	Explosives....	.....	230.00							
	Drill parts....	.....	25.00							
	Steel.....	.....	30.00							
31	Warehouse expense	4-119	10.69	.27	4.33	.24	.44	.10	.....	16.07
31	Assaying.....	12-119	.....	.....	.....	.....	.....	.....	$121.23	121.23
31	Power.....	10-119	.....	.....	.....	.....	33.00	.....	.....	33.00
31	Air.....	11-119	360.72	.....	.....	.....	.....	.....	.....	360.72
31	To mining.....	14-119	.....	.....	.....	.....	.....	.....	.....	a 750.00

a Credit; to be posted in red ink.

Freight and treatment.

Date.	Item.	Voucher No.	Amount (Dr.).	Date.	Item.	Voucher No.	Amount (Cr.).
(1919) Jan. 31	.....	17-119	$875.00	(1919)			

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Freight and treatment payable.

Date.	Item.	Voucher No.	Amount (Dr.).	Date.	Item.	Voucher No.	Amount (Cr.).
				(1919) Jan. 31	.....	17–119	$875.00

General surface expense.

Date.	Item.	Voucher No.	Amount (Dr.).	Date.	Item.	Voucher No.	Amount (Cr.).
(1919) Jan. 31	January pay-roll distribution	1–119	$90.00	(1919)			
31	Stable	13–119	14.74				

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Gold sales.

Date.	Item.	Voucher No.	Amount (Dr.).	Date.	Item.	Voucher No.	Amount (Cr.).
				1919. Jan. 31	.....	16–119	$1,240.60

Hospital.

Date.	Item.	Voucher No.	Amount (Dr.).	Date.	Item.	Voucher No.	Amount (Cr.).
(1919.) Jan. 31	January pay roll.....	1–119	$250.00	(1919.) Jan. 31	Pay-roll deductions...	3–119	$325.00
31	January supplies.....	2–119	50.00				
31	Warehouse expense....	4–119	1.72				
31	Light.....	10–119	60.50				

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Insurance.

Date.	Item.	Folio No.	Amount (Dr.).	Date.	Item.	Folio No	Amount (Cr.).
(1919.) Jan. 31	.....	V-1	$600.00				

Office expense.

Date.	Item.	Voucher No.	Amount (Dr.).	Date.	Item.	Voucher No.	Amount (Cr.).
(1919.) Jan. 31	January pay-roll distribution.....	1-119	$375.00				
31	January supplies.....	2-119	12.00				
31	.....	V-1	107.00				
31	Warehouse expense....	4-119	.40				
31	Light.....	10-119	33.00				
31	Stable.....	13-119	14.74				

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Pay roll.

Date.	Item.	Folio or voucher No.	Amount (Dr.).	Date.	Item.	Folio or voucher No.	Amount (Cr.).
(1919.)				(1919.)			
Jan. 31	Hospital deductions....	3–119	$325.00	Jan. 31	January pay roll....	1–119	$12,455.00
31	Board deductions.....	3–119	2,900.00				
31	.....	V–1	59.00				

Power plant.

Date.	Item.	Vo. No.	Boilers.	Feed water.	Corliss engine.	Generator.	Compressor.	(a)	Total (Dr.).
(1919)									
Jan. 31	January pay roll:.....	1–119	$360.00	$60.00	$170	$170.00	$170.00	....	$930.00
31	" Supply distr.....	2–119	.....	6.00	.....	10.00	.....	....	803.00
	" Fuel.....	.....	600.00						
	" Other supplies.....	.....	20.00	.....	14	.....	13.00		
	" Oil, grease, and waste...	.....	.....	.....	70	.....	70.00		
31	Cash.....	V–1	.....	75.00	.....	.....	.....	....	75.00
31	Warehouse expense.....	4–119	21.38	20	2.89	.35	2.86	....	27.68
31	Charged shops.....	6–119	.....	.....	.....	b 70.00	.....	....	b 70.00
31	Shop expenses.....	7–119	100.00	.....	75	75.00	50.00	....	300.00
31	Distribution of steam....	8–119	b1,101.38	b141.20	1,242.58				
31	"	9–119	.....	.....	b1,574.47	787.23	787.24		
31	Distributed.....	10–119	.....	.....	.....	b972.58	.....	....	b972.58
31	"	12–119	.....	.....	.....	.....	b1,093.10	....	b1,093.10

a Extra column, for additional entry if desired.
b Credit, to be posted in red ink.

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Purchase discounts.

Date.	Item.	Voucher or folio No.	Amount (Dr.).	Date.	Item.	Voucher or folio No.	Amount (Cr.).
				(1919) Jan. 31	.....	V-1	30.00

Machine shop (operating).

Date.	Item.	Voucher No.	Amount (Dr.).	Date.	Item.	Voucher No.	Amount (Cr.).
(1919) Jan. 31	January pay roll distribution.....	1-119	$220.00	(1919) Jan. 31	Distributed.....	7-119	$452.64
	January supplies:						
	Steel.....	2-119	47.00				
	Iron.....	2-119	28.00				
	Hardware.....	2-119	15.00				
	Tools.....	2-119	8.00				
	Waste.....	2-119	7.00				
	Oil.....	2-119	6.00				
	Other supplies.....	.....	4.00				
31	Warehouse expense....	6-119	3.98				
31	Machine shop expense..	6-119	68.66				
31	Power used.....	5-119	45.00				

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Machine shop expense.

Date.	Item.	Voucher No.	Amount (Dr.).	Date.	Item.	Voucher No.	Amount (Cr.).
(1919) Jan. 31	January pay roll.....	1–119	$49.00	(1919) Jan. 31	Transfer.....	6–119	$68.66
31	January supplies.....	2–119	19.00				
31	Warehouse expense....	4–119	.66				

Metals in transit.

Date.	Item.	Folio or voucher No.	Amount (Dr.).	Date.	Item.	Folio or voucher No.	Amount (Cr.).
(1919) Jan. 31	.....	16–119	$22,500.00	(1919) Jan. 31	.....	P–1	$8,000.00

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Milling.

Date.		Voucher No.	Ore bins, grizzlies, and conveyors.	Coarse crushing.	Fine crushing.	Elevators.	Concentrating.
(1919.)							
Jan. 31	January pay roll distribution	1–119	$90.00	$310.00	$310.00	$40.00	$1,400.00
	January supply distribution	2–119					
	Wearing parts			75.00	60.00		300.00
	Other supplies			8.00	16.00	9.00	60.00
	Buckets					115.00	
31	Warehouse expense	4–119		2.86	2.62	4.28	12.41
31	Assaying	12–119					
31	Shop expenses	7–119		100.00	150.00	50.00	500.00
31	Power	10–119					
31	Stable	13–119					
31	Mining and tramming	15–119					

Mining.

Date.	Item.	Voucher No.	Breaking ore.	Underground tramming.	Timbering.
(1919.)					
Jan. 31	January pay roll distribution	1–119	$3,000.00	$150.00	$300.00
	January supply distribution	2–119		15.00	250.00
	Explosives		450.00		
	Drill parts		50.00		
	Steel		60.00		
	Other supplies		50.00		
31	Warehouse expense	4–119	21.03	.52	8.63
31	Assaying	5–119			
31	Shop accounts	7–119	50.00		45.00
31	Power	10–119			
31	Air	11–119	732.38		
31	Stable	13–119			
31	At 25c. per ton	14–119			
31	To milling	15–119			

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Milling—Continued.

Tailings.	General mill expense.	Mining and tramming.	Stable expense.	Assaying	Power.	Lighting.	Heating.	Total (Dr.).
$270.00	$80.00	.....	.....	.....	.....	.....	.....	$2,500.000
7.00	5.00	.....	.....	.....	.....	.....	.....	655.00
.24	.17	.....	.....	.....	.....	.....	.....	22.58
.....	.....	.....	.....	$161.63	.....	.....	.....	161.63
100.00	.....	.....	.....	.....	.....	.....	.....	900.00
.....	.....	.....	.....	.....	$444.58	$92.40	$137.50	674.48
.....	.....	.....	$176.84	.....	.....	.....	.....	176.84
.....	.....	$6,629.77	.....	.....	.....	.....	.....	6,629.77

Mining—Continued.

Hoisting.	Sampling.	Drill sharpening.	Surface expense.	Assaying.	Stable expense.	Development.	Total (Dr.).[a]
$450.00	$100.00	$80.00	$75.00	.....	.....	.....	$4,155.00
18.00	6.00	5.00	8.00	.....	.....	.....	912.00
.62	.20	.17	.27	.....	.....	.....	31.44
.....	.....	.....	.....	$363.68	.....	.....	363.68
15.00	10.00	.....	.....	.....	.....	.....	120.00
88.00	.....	.....	.....	.....	.....	.....	88.00
.....	.....	.....	.....	.....	.....	.....	732.38
.....	.....	.....	.....	.....	$147.36	.....	147.36
.....	.....	.....	.....	.....	.....	$750.00	750.00
.....	.....	.....	.....	.....	.....	.....	[b] 6,083.22

[a] If more columns are necessary, cut the desired number of columns from another page and place in ledger on top of first page of mining account.
[b] Credit; post in red ink.

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Warehouse account.

Date.	Item.	Voucher No.	Amount (Dr.).	Date.	Item.	Voucher No.	Amount (Cr.).
(1919.) Jan. 31	.....	V-1	$15,059.00	(1919.) Jan. 31	January supply distribution.....	.....	$6,042.00

Warehouse expense.

Date.	Item.	Folio or voucher No.	Amount (Dr.).	Date.	Item.	Folio or voucher No.	Amount (Cr.).
(1919.) Jan. 31	January pay roll distribution.....	1-119	$200.00	(1919.) Jan. 31	Distributed on issues.	4-119	$208.00
	January supplies.....	2-119	8.00				

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Silver sales.

Date.	Item.	Voucher No.	Amount (Dr.).	Date.	Item.	Voucher No.	Amount (Cr.).
				(1919.) Jan. 31	.....	16–119	$1,259.80

Stable expense.

Date.	Item.	Voucher No.	Amount (Dr.).	Date.	Item.	Voucher No.	Amount (Cr.).
Jan. 31	January pay roll distribution.	1–119	$180.00	Jan. 31	Distributed.....	13–119	$353.68
	January supplies:						
	Hay.....	2–119	75.00				
	Grain.....	.....	60.00				
	Other.....	.....	8.00				
31	Warehouse expense...	4–119	4.93				
31	Shop expense.....	7–119	19.15				
31	Power.....	10–119	6.60				

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Taxes.

Date.	For what year.	Voucher No.	Amount (Dr.).	Date.	For what year.	Voucher No.	Amount (Cr.).
(1919) Jan. 31	For 1919.....	V-1	$1,200.00				

Tramway.

Date.	Item.	Voucher No.	Amount (Dr.).	Date.	Item.	Voucher No.	Amount (Cr.).
(1919) Jan. 31	January pay roll distribution.	1-119	$450.00	(1919) Jan. 31	To milling.....	15-119	$546.55
	January supply distribution.	2-119	16.00				
31	Warehouse expense....	4-119	.55				
31	Shop expense.....	7-119	80.00				

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PUBLICATIONS AVAILABLE FOR FREE DISTRIBUTION.

BULLETIN 48. The selection of explosives used in engineering and mining operations, by Clarence Hall and S. P. Howell. 1914. 50 pp., 3 pls., 7 figs.

BULLETIN 57. Safety and efficiency in mine tunneling, by D. W. Brunton and J. A. Davis. 1914. 271 pp., 6 pls., 45 figs.

BULLETIN 62. National mine rescue and first aid conference, Pittsburgh, Pa., September 23–26, 1912, by H. M. Wilson. 1913. 74 pp.

BULLETIN 74. Gasoline mine locomotives in relation to safety and health, by O. P. Hood and R. H. Kudlich, with a chapter on methods of analyzing exhaust gases, by G. A. Burrell. 1915. 84 pp., 3 pls., 27 figs.

BULLETIN 75. Rules and regulations for metal mines by W. R. Ingalls and others. 1915. 296 pp., 1 fig.

BULLETIN 80. A primer on explosives for metal mines and quarrymen, by C. E. Munroe and Clarence Hall. 1915. 125 pp., 51 pls., 17 figs.

BULLETIN 132. Siliceous dust in relation to pulmonary disease among miners in the Joplin district, Missouri, by Edwin Higgins, A. J. Lanza, F. B. Lancy, and G. S. Rice. 1917. 116 pp., 16 pls., 6 figs.

BULLETIN 139. Control of hookworm infection at the deep gold mines of the Mother Lode, California, by J. G. Cumming and J. H. White. 1917. 52 pp., 1 pl., 5 figs.

BULLETIN 144. Report of a joint committee appointed from the Bureau of Mines and the United States Geological Survey by the Secretary of the Interior to study the gold situation. 1919. 84 pp., 1 pl., 3 figs.

BULLETIN 154. Mining and milling of lead and zinc ores in the Missouri-Kansas-Oklahoma zinc district, by C. A. Wright and H. A. Buehler. 1918. 134 pp.

BULLETIN 157. Innovations in the metallurgy of lead, by D. A. Lyon and O. C. Ralston. 1918. 167 pp.

BULLETIN 168. Recovery of zinc from low-grade and complex ores, by D. A. Lyon and Oliver C. Ralston. 1919. 143 pp., 23 figs.

BULLETIN 174. Abstracts of current decisions on mines and mining, reported from May to September, 1918, by J. W. Thompson. 1919. 138 pp. Earlier bulletins of this series still available for free distribution are 172 (January to May, 1918), 126 (January to April, 1916), 118 (October to December, 1915), 101 (October, 1914, to April, 1915), 90 (December, 1913, to September, 1914). For 164, 159, 152, 147, 143, 113, 79, and 61 see sale list on page 63.

TECHNICAL PAPER 4. The electrical section of the Bureau of Mines, its purpose and equipment, by H. H. Clark. 1911. 12 pp.

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TECHNICAL PAPER 13. Gas analysis as an aid in fighting mine fires, by G. A. Burrell and F. M. Seibert. 1912. 16 pp., 1 fig.

TECHNICAL PAPER 19. The factor of safety in mine electric installations, by H. H. Clark. 1912. 14 pp.

TECHNICAL PAPER 30. Mine-accident prevention at Lake Superior iron mines, by D. E. Woodbridge. 1913. 38 pp., 9 figs.

TECHNICAL PAPER 58. Action of acid mine water on the insulation of electrical conductors, a preliminary report, by H. H. Clark and L. C. Ilsley. 1913. 26 pp., 1 fig.

TECHNICAL PAPER 59. Fires in Lake Superior iron mines, by Edwin Higgins. 1913. 34 pp., 2 pls.

TECHNICAL PAPER 82. Oxygen mine rescue apparatus and physiological effects on users, by Yandell Henderson and J. W. Paul. 1917. 102 pp., 5 pls., 6 figs.

TECHNICAL PAPER 95. Mining and milling of lead and zinc ores in the Wisconsin district, Wisconsin, by C. A. Wright. 1915. 39 pp., 2 pls., 5 figs.

TECHNICAL PAPER 103. Organizing and conducting safety work in mines, by H. M. Wilson and J. R. Fleming. 1917. 57 pp., 35 figs.

TECHNICAL PAPER 105. Pulmonary disease in the Joplin district, Missouri, and its relation to rock dust in the mines, by A. J. Lanza and Edwin Higgins. 1915. 48 pp., 5 pls., 4 figs.

TECHNICAL PAPER 112. The explosibility of acetylene, by G. A. Burrell and G. G. Oberfell. 1915. 15 pp.

TECHNICAL PAPER 122. Effects of oxygen deficiency on small animals and on men, by G. A. Burrell and G. G. Oberfell. 1915. 12 pp.

TECHNICAL PAPER 132. Underground latrines for mines, by J. H. White. 1916. 23 pp., 2 pls., 7 figs.

TECHNICAL PAPER 134. Explosibility of gases from mine fires, by G. A. Burrell and G. G. Oberfell. 1916. 31 pp., 1 fig.

TECHNICAL PAPER 174. Suggestions for the safe operation of gasoline engines in mines, by R. H. Kudlich and Edwin Higgins. 1917. 19 pp., 3 figs.

TECHNICAL PAPER 196. Notes on the black sand deposits of southern Oregon and northern California, by R. R. Horner. 1918. 40 pp.

TECHNICAL PAPER 215. Accidents at metallurgical works in the United States during the calendar year 1917, by A. H. Fay. 1919. 23 pp.

TECHNICAL PAPER 222. Method of administering leases of iron-ore deposits belonging to the State of Minnesota, by J. R. Finlay. 1919. 40 pp., 1 fig.

TECHNICAL PAPER 223. Cost keeping for small metal mines, by J. C. Pickering. 1919. 46 pp.

TECHNICAL PAPER 224. Metal-mine accidents in the United States during the calendar year 1917, with supplemental labor and accident tables for the years 1911 to 1917, inclusive, by A. H. Fay. 1919. 80 pp.

MINERS' CIRCULAR 4. The use and care of mine-rescue breathing apparatus, by J. W. Paul. 1911. 24 pp., 5 figs.

MINERS' CIRCULAR 5. Electrical accidents in mines, their causes and prevention, by H. H. Clark, W. D. Roberts, L. C. Ilsley, and H. F. Randolph. 1911. 10 pp., 3 pls.

MINERS' CIRCULAR 10. Mine fires and how to fight them, by J. W. Paul. 1912. 14 pp.

MINERS' CIRCULAR 11. Accidents from mine cars and locomotives, by L. M. Jones. 1912. 16 pp.

MINERS' CIRCULAR 13. Safety in tunneling, by D. W. Brunton and J. A. Davis. 1913. 19 pp.

MINERS' CIRCULAR 17. Accidents from falls of rock and ore, by Edwin Higgins. 1914. 15 pp., 8 figs.

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MINERS' CIRCULAR 18. Notes on miners' carbide lamps, by J. W. Paul. 1915. 11 pp.

MINERS' CIRCULAR 19. The prevention of accidents from explosives in metal mining, by Edwin Higgins. 1914. 16 pp., 11 figs.

MINERS' CIRCULAR 23. Elementary first aid for the miner, by W. A. Lynott and D. Harrington. 1916. 24 pp., 19 figs.

Rescue and recovery operations in mines after fires and explosions, by J. W. Paul and H. M. Wolflin. 1916. 109 pp.

Advanced first-aid instructions for miners, a report on standardization, by a committee of surgeons, G. H. Halberstadt, A. F. Knoefel, W. A. Lynott, W. S. Rountree, and M. J. Shields. 1917. 142 pp., 65 figs.

PUBLICATIONS THAT MAY BE OBTAINED ONLY THROUGH THE SUPERINTENDENT OF DOCUMENTS.

BULLETIN 94. United States mining statutes annotated, by J. W. Thompson. 1915. 1,772 pp. In two parts, not sold separately. Cloth, $2.50 per set; paper, $2.

BULLETIN 107. Prospecting and mining of copper ore at Santa Rita, N. Mex., by D. F. MacDonald and Charles Enzian. 1916. 122 pp., 10 pls., 20 figs. 25 cents.

BULLETIN 111. Molybdenum; its ores and their concentration, with a discussion of market prices and uses, by F. W. Horton. 1916. 132 pp., 18 pls., 2 figs. 30 cents.

BULLETIN 121. The history and development of gold dredging in Montana, by Hennen Jennings, with a chapter on placer-mining methods and operating costs, by Charles Janin. 1916. 64 pp., 29 pls., 1 fig. 30 cents.

BULLETIN 127. Gold dredging in the United States, by Charles Janin. 1918. 224 pp. 50 cents.

BULLETIN 150. Electrodeposition of gold and silver from cyanide solutions, by S. B. Christy. 1919. 171 pp., 8 pls., 41 figs. 25 cents.

BULLETIN 153. The mining industry in the territory of Alaska during the calendar year 1916, by S. S. Smith. 1918. 85 pp. 10 cents.

BULLETIN 161. California mining statutes annotated, by J. W. Thompson. 1918. 312 pp. 20 cents.

BULLETIN 164. Abstracts of current decisions on mines and mining, September to December, 1917, by J. W. Thompson. 1918. 147 pp. 20 cents. Other bulletins of this series for sale are: 159 (May to August, 1917), 15 cents; 152 (January to April, 1917), 10 cents; 147 (September to December, 1916), 10 cents; 143 (May to August, 1916), 10 cents; 113 (May to September, 1915), 15 cents; 79 (March to December, 1913), 20 cents; 61 (October, 1912, to March, 1913) 10 cents. For those on the free list see page 61.

BULLETIN 169. Illinois mining statutes annotated, by J. W. Thompson. 1918. 594 pp. 35 cents.

TECHNICAL PAPER 17. The effect of stemming on the efficiency of explosives, by W. O. Snelling and Clarence Hall. 1912. 20 pp., 11 figs. 5 cents.

TECHNICAL PAPER 24. Mine fires, a preliminary study, by G. S. Rice. 1912. 51 pp., 1 fig. 5 cents.

TECHNICAL PAPER 29. Training with mine-rescue breathing apparatus, by J. W. Paul. 1912. 16 pp. 5 cents.

TECHNICAL PAPER 41. The mining and treatment of lead and zinc ores in the Joplin district, Mo., a preliminary report, by C. A. Wright. 1913. 43 pp., 5 figs. 5 cents.

TECHNICAL PAPER 67. Mine signboards, by Edwin Higgins and Edward Steidle. 1913. 15 pp., 1 pl., 4 figs. 5 cents.

TECHNICAL PAPER 77. Report of the committee on resuscitation from mine gases, by W. B. Cannon, G. W. Crile, Joseph Erlanger, Yandell Henderson, and S. J. Maltzer. 1914. 35 pp., 4 figs. 5 cents.

MINERS' CIRCULAR 15. Rules for mine-rescue and first-aid field contests, by J. W. Paul. 1913. 12 pp. 5 cents.

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